ALPH_W03 2-20-03

SOME EMPIRICAL α DECAY HALFLIVES

Initial	Final	Energy(MeV)	Halflife	Halflife (sec.)
$^{238}_{92}U$	$^{234}_{90}Th$	4.21	4.51 yr	$1.4 \cdot 10^{17}$ sec
$^{214}_{84}Po$	$^{210}_{82}Pb$	7.68	$1.55 \cdot 10^{-4}$ sec	$1.55 \cdot 10^{-4}$ sec

Halflife without barrier :

$$t_{1/2} = t_N \, e^I$$

where t_N is the halflife in the absence of a barrier:

$$t_N \approx \frac{R_N}{v_\alpha}$$

$R_N \approx 3fm = 3 \cdot 10^{-15}m$ is the nuclear radius
$v_\alpha \approx \frac{1}{10} \, c \approx 3 \cdot 10^7$ m/sec is the alpha velocity inside the nucleus
Thus $t_N \approx 10^{-22}$ sec. Short!!

Some constants
$\frac{e^2}{\hbar \, c} = \frac{1}{137.06}$
$\hbar \, c \ = 197.32 MeV \, fm$
$e^2 = 1.44 MeV fm$
$log_{10} \, e = 0.4343$

Barrier Integral

$$I \approx \left(2 \, \pi \, z \, Z \, \frac{e^2}{\hbar \, c} \, \frac{c}{v} \right) \left(1 \, - \, \frac{4}{\pi} \sqrt{\frac{R_0}{R_i}} \right)$$

$$I \approx 3.96 \, \frac{Z}{\sqrt{E_\alpha}} \, - 8.13 \, \sqrt{Z}$$

$R_0 = 1.25 \, A^{1/3} fm \approx 7.5 fm$
$R_i = \frac{z \, Z \, e^2}{E_\alpha}$
For $^{238}_{92}U$ decay, z = 2, Z = 90, I = 174 - 77 = 97.
$e^{97} \approx 10^{42}, t \approx 10^{-22} \cdot 10^{42} \approx 10^{20} sec$
For $^{214}_{84}Po$ decay, z = 2, Z = 82, I = 117 - 74 = 43.
$e^{43} \approx 10^{19}, t \approx 10^{-22} \cdot 10^{19} \approx 10^{-3} sec$